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Signature

K/EM-106

SURVEY OF CONTROL OVER SOURCE AND SPECIAL NUCLEAR MATERIALS UNION CARBIDE NUCLEAR CORPORATION (ORGDP)

(Sanitized Version of SRD Document # KZ-8165–dated June 19, 1961)

Compiled by
S. G. Thornton
Environmental Management Division
OAK RIDGE K-25 SITE
for the Health Studies Agreement

May 1995

Oak Ridge K-25 Site
Oak Ridge, Tennessee 37831-7101
managed by MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the U.S. DEPARTMENT OF ENERGY
under Contract DE-AC05-84OR21400

TOP SECRET

UNION CARBIDE NUCLEAR COMPANY

A Division of UNION CARBIDE CORPORATION

Operating the ATOMIC ENERGY COMMISSION'S

Oak Ridge Gaseous Diffusion Plant

Paducah Gaseous Diffusion Plant

Portsmouth Gaseous Diffusion Plant

Oak Ridge National Laboratory

UNION CARBIDE

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UCN-8001 (10-58)

TOP SECRET

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UNITED STATES
ATOMIC ENERGY COMMISSION

IN REPLY REFER TO:
OPA:WEK

Oak Ridge, Tennessee
June 19, 1961

Copy
Forwarded By
C. E. Center

Union Carbide Nuclear Company
Post Office Box P
Oak Ridge, Tennessee

Attention: Mr. C. E. Center, Vice President

Subject: SS NUCLEAR MATERIALS CONTROL SURVEY - NO. OR-147
STATION CCC (ORGDP)

Gentlemen:

Transmitted herewith is a narrative report of Nuclear Materials Control Survey No. OR-147, recently made at Station CCC.

We greatly appreciate the cooperation given by members of your organization during the course of the survey.

Very truly yours,

S. R. Sapirie
Manager
Oak Ridge Operations

Enclosure:
Survey Report No. OR-147, XIII-1625-2A

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Form

SURVEY OF CONTROL OVER SOURCE AND SPECIAL NUCLEAR MATERIALS - UCNC - ORGDP

SURVEY NO. OR-147

STATION CCC

I. INTRODUCTION

1.1 - A survey of the control over source and special nuclear (SS) materials by the Union Carbide Nuclear Company, K-25 Area, Oak Ridge, Tennessee (Station CCC), was made by the Nuclear Materials Control Branch, Production Division, Oak Ridge Operations Office.

1.2 - The survey was conducted during the period January 25, 1961, to March 3, 1961, and covered the physical inventory on January 31, 1961, and transactions occurring during the twelve months preceding that inventory.

II. GENERAL STATUS

2.1 - Under the provisions of cost-plus-a-fixed fee Contract No. W-7405-Eng-26, as amended, the Union Carbide Nuclear Company, Union Carbide Corporation, is engaged to manage, operate and maintain a Gaseous Diffusion Plant (comprised of the K-25, K-27, K-29, K-31 and K-33 sections, a UF_6 Feed Manufacturing Plant and auxiliary and service facilities, and facilities for the production of barrier materials).

2.2 - The functions to be performed include the production of uranium enriched in the Uranium-235 isotope; the preparation of UF_6 feed; the production of barrier materials; and related research and development services.

2.3 - Article XXIV, of the above cited contract, provides that "the Corporation shall comply with all regulations and instructions of the AEC relative to the control of and accounting for source and special nuclear materials", make such reports and permit such inspections as the AEC may require, and the Corporation shall take all reasonable steps and precautions to protect such materials against theft and misappropriation and to minimize all avoidable losses of such materials.

2.4 - CERTIFICATION: It is our opinion that Station CCC has presented fairly its inventory of SS materials as of January 31, 1961, and the results of its SS materials transactions for the 12 month period then ended, in accordance with the regulations and instructions of the AEC insofar as the control of SS materials is concerned. The material balance report presented herein as Appendix C is substantiated by our verification of measurements, selected inventories, and the recording of the applicable transactions. It is our opinion that the quantitative results obtained by the Contractor and presented to the AEC as statements of inventory and transactions are true and valid for all material types within the expected and reasonable limits of uncertainty of the applicable measurements. These quantities can be expected to yield statements for production cost accounting and other purposes, if subsequent extensions and selections of categories are properly performed.

2.5 - The confirmation of the necessary utilization of SS materials under allocation is furnished by allotment number as Appendix D to this survey report.

III. SCOPE OF THE SURVEY

3.1 - We made comprehensive analyses of the SS material control and subsidiary ledgers and tested supporting documents to the extent and in the manner deemed necessary. Our determination of the degree of internal control exercised by the Contractor was made as a result of a review of material flows, corresponding documentation, and the manner of origin and completion of the data.

3.2 - The statistical analyses of SS data accumulated at Station CCC were made the subject of review and verification. We established the correctness of the techniques applied and ascertained that the implementing procedures followed the pattern established in prior surveys. The results obtained were compared to our findings on the statistical programs of other stations using comparable methods, and with accepted standards for quality control programs.

3.3 - Our confirmation of the accuracy of the measurements performed at Station CCC consisted of a review of the applicable scales and balances inclusive of precision, quality control and frequency of calibration; examination of SS material flows; location of sampling points and observation of the methods used to withdraw samples of SS materials; a tour of the analytical laboratories with a review of the equipment and procedures used; and conferences with laboratory personnel concerning the techniques used and the precision of each.

3.4 - Verification of the physical inventory of SS materials at Station CCC consisted of observation of the inventory procedures inclusive of the listing, sampling and weighing practices; obtaining copies of those inventories which we had seen recorded; and subsequent comparison and reconciliation with IBM records, ledgers and material balance reports prepared by Station personnel. Test listings and notations of test weighings were made by the survey group and verified to the material control records. The inventory quantity verified constituted 26 percent of the physical inventory less the Cascade. The areas selected for inventory verification follow:

Area No.	Description
115	Cascade Storage - UF_6 Feed Point - Paducah Product
120	Cascade Storage - Depleted UF_6 Withdrawal
125	Cascade Storage - Feed Manufacture Feed Point
140	Cascade Storage - Product Withdrawal
150	Cascade Storage - Side Feed
390	Recovery From Solutions
410	Oxide Fluorination (Conversion)
550	Feed Manufacture (Control for Oxide Receipts)
551	Feed Manufacture (UF_4 Process)
552	Feed Manufacture (UF_6 Process)
553	Feed Manufacture (Ash)
730	Decontamination - Continuous Dissolver
951	Coded Chemicals - "SS" Storage
960	Coded Chemicals - Special Sampling (Any Location)

IV. PERTINENT FINDINGS

4.1 - The following pertinent findings are relatively minor in nature, have been discussed with the Contractor, and remedial action has either been instigated or will be accomplished in the immediate future.

4.2 - We found that signatures had been omitted from various types of internal material transfer documents, e. g., intraplant transfers, adjustment journal sheets, tally-in documents (see paragraph 12.3).

4.3 - Weight tickets, including those issued in support of licensee receipts and shipments, did not disclose in all instances cross-references to the applicable AEC-388 transfer documents or to the AEC-101's (see paragraph 13.2).

4.4 - The IBM tabulation which represents the year-to-date quantities in the material control ledger is not prepared until after the material balance reports have been submitted to the AEC. An instance occurred wherein this tabulation failed to agree with the material balance report (see paragraph 13.2).

4.5 - The December 31, 1960, material balance report, cumulative section, erroneously included a receipt from licensee, Spencer Chemical Company, as a receipt from licensee, Mallinckrodt Chemical Works. The initial receipt of the material, in October 1960, had been correctly reported in the October 31, 1960, report (see paragraph 13.4).

4.6 - The cumulative quantity of shipments on the material balance report of January 31, 1961, included a removal to licensee, Davison Chemical Company of 779,705 grams uranium and 20,239 grams U-235. The shipment had been made to the licensee, Mallinckrodt Chemical Works, Nuclear Division, and was so reported in the monthly section of the material balance report (see paragraph 13.4).

V. RECOMMENDATIONS

5.1-- There were no recommendations made as a result of the prior Survey No. OR-135.

5.2 - Our evaluation of the adequacy of the SS material control program at Station CCC discloses, in our opinion, no need for any current recommendations.

VI. FEED MANUFACTURING PLANT

6.1 - Measurements - The weights obtained by ORGDP are the accepted accountability weights for all receipts and shipments.

6.2 - Both full and empty 5-ton "Nooter" hoppers are weighed on a 20,000 lb. capacity Toledo print-weight (platform type) scale which has graduated increments of 2 lbs. The scale is checked with a full load test hopper weight (11,520 lbs.) before and during the weighing of each group of incoming hoppers. The scale is also calibrated upon request of operations by scale maintenance utilizing secondary standard weights.

6.3 - The feed consists of (1) depleted UO_3 from Station SRO, (2) normal UO_3 from Port Hope, (3) normal UO_3 from station NLO and (4) slightly enriched (depleted 0.94% U-235) UO_3 from Station HGE.

6.4 - A composite sample accompanies each trailer shipment (three 5-ton hoppers) of UO_3 from Station SDA. The composite sample is analyzed for total uranium by the gravimetric procedure and the U-235 content is determined by the mass spectrometer.

6.5 - For sample control purposes, one individual hopper of every third shipment is sampled and analyzed for both total uranium and U-235 content. The results from these analyses are then compared with the analytical results obtained by Station CCC on SDA's composite sample.

6.6 - Each 5-ton hopper of Port Hope oxide containing approximately 10,000 lbs. UO_3 is weighed on the 20,000 lb. capacity Toledo print weight scale mentioned above.

6.7 - Two composite samples accompany each lot of 10-5 ton hoppers of material received from Port Hope on rail cars. One sample is analyzed for total uranium and the other sample is retained for further use if needed. Every fifth lot composite is analyzed by Station CCC for all contract specifications.

6.8 - Uranium trioxide is also received from Station NLO in 5-ton hoppers (three 5-ton hoppers per truck). A composite sample accompanies each trailer shipment and this composite sample is analyzed for both total uranium and U-235 content. Station NLO's samples are utilized since Station CCC has evaluated and proven NLO's sampling techniques. However, Station CCC applies its own weights and analytical measurements.

6.9 - At the time of survey, some slightly enriched U_3O_8 from Station CYT was being received in 30 gallon drums. Each drum is weighed on a 1000 lb. capacity Toledo scale which has recorded increments of 1/4 lb. The scale is calibrated with working standards before and after its use. For accountability purposes, Station CCC applies their weights and the shipper's analyses are accepted.

6.10 - Feed Plant product UF_6 is drawn off as a liquid into both 2.5 and 10 ton cylinders. The 2.5 ton cylinders are drain line sampled as they are being filled from the secondary cold traps and the 10-ton cylinders are drain line sampled as they are being filled from the primary cold traps (modine traps).

6.11 - Each drain line sample is submitted to the laboratory and analyzed for total uranium by pyro-hydrolysis gravimetric procedure and the U-235 content is determined by the mass spectrometer. The results of these analyses are the accepted accountability values for all shipments of Feed Plant product.

6.12 - Each cylinder of UF_6 is weighed on a Howe Mechanoprint scale which has a capacity of 30,000 lbs. and recorded increments of 5.0 lbs. This scale is checked before and during the weighing of each group of cylinders with standard check-weigh hoppers and at any other time by scale maintenance upon request of operations. The cylinders are kept on load cells continuously to indicate to the operating personnel when a cylinder is nearing the filling limit. The official weights are determined by coded chemicals personnel at the Feed Plant. The chlorine cylinders (2.5 ton) to be fed locally are also checked for control purposes at the feed point in Bldg. K-33. This scale is a 10,000 lb. capacity Howe Mechanoprint which records in 2 lb. increments and can be interpolated to the nearest 1 lb. The 10-ton cylinders containing approximately 21,000 lbs. UF_6 when filled are transferred to Station CKY as feed for their Cascade.

6.13 - Barrier filters are removed periodically from the system when an indication of plugging is noted. The plugged barrier tubes are transferred to Bldg. K-1410 where they are vacuumed dry and processed in the carbonate soak tank. A liquid sample of carbonate solution is withdrawn from the tank and the sample is analyzed for both total uranium and U-235.

6.14 - Residues: Ash from the fluorination towers in the Feed Manufacturing Plant are pulverized and screened in Bldg. K-1131 and prepared for refeeding to the fluorine towers. The ash is received at the same estimate on which it was removed.

6.15 - Each ash can weighing approximately 250 lbs. with an average SS content of 70% is weighed on a 750 lb. capacity Toledo portable scale which has recorded increments of 1/4 lb. This scale is calibrated by scale maintenance once per month.

6.16 - Inventory Procedures - The gross, tare and net weights of all 5-ton "Nooter" hoppers and both 2.5 and 10 ton cylinders that are on hand at inventory are listed. The empty hoppers are separated from the full hoppers and the "heels" in the empty hoppers are listed accordingly. The amount of material in-process is calculated on the basis of engineering evaluations and all residues are drummed and weighed.

6.17 - Inventory Verification - (by AEC) - Members of the survey team participated in the physical listings of cylinders, hoppers and the taking of the in-process inventory. Neither sampling nor check-weighing was performed in this area; however, carbon copies of the Feed Plant inventory were taken to be reconciled to the Contractor's records.

6.18 - There were no discrepancies noted where the operations personnel taking the inventory failed to comply with established written procedures as outlined in the Procedures Manual.

6.19 - The survey team had some difficulty in trying to properly identify certain cylinders which were to be listed on the inventory. The difficulty was attributed primarily to the manner in which these cylinders had been stored. The cylinder numbers were later verified and the inventory was accepted.

6.20 - Opinion - It is the opinion of the survey team that the control of SS material in this area is adequate and in keeping with good accountability practices.

VII. CASCADE

7.1 - Measurements - Measurements in the Cascade are essentially the same as those discussed in the previous survey report (No. OR-135). These measurements include all separating and purge equipment, surge for purge systems, feed points and withdrawal points, test loops, the product purification unit and various piping connecting the equipment. The official plant Cascade inventory is normally taken at 2400 on the last day of each month. Every effort is made to insure that the Cascade is operating as smoothly as possible during inventory, consequently no changes in unit operations are attempted during an eight-hour period immediately preceding the inventory, unless some emergency arises.

7.2 - The inventory calculation is based on a set of inventory equations (circuit balances) which places this calculation on a consistent and flexible basis and incorporates recent improvements on stage properties. This method of inventory makes it possible to determine directly the effect of a change in pressure, control valve position, light gas concentration, or temperature on the inventory of any cell or unit within the range for which the equation is established.

7.3 - Circuit balance equations are designed for computing the inventory of new equipment (cell). Each type of equipment demands a specific set of circuit balance equations. The circuit balance equations for the K-27 Building have been re-evaluated in order to incorporate the different features of a new pump (Cooper-Bessmer) recently installed in this area.

7.4 - No other significant changes had been made which required new circuit balance calculations for this Cascade inventory, and therefore the inventory was based on past circuit balance calculations and gas law equations.

7.5 - Uranium solids or any UF_6 absorbed on the internal surfaces of the Cascade are not included in the Cascade inventory. All cylinders in the vaporizers are weighed on a 10,000 lb. capacity Howe Mechanoprint scale which has recorded increments of 20 lbs. The scale is checked twice per shift by operations personnel and at any time upon request.

7.6 - The uranium and U-235 content of Paducah product received at Station CCC is based on the ORGDP weight and CKY's analyses. If gross weight differences between the two stations exceed six (6) pounds, the ORGDP receiving weight is verified by reweighing the subject container and afterwards checking the scale calibration utilizing the test weight at the receiving location. The cylinder in question is then fed at the verified weight and the weight is entered into the ORGDP records.

7.7 - Each cylinder of tails is weighed on a 10,000 lb. capacity Howe Mechanoprint scale which has recorded increments of 1.0 lb. The scale is checked twice per shift by operating personnel and upon request by scale maintenance.

7.8 - A drain-line sample (Harshaw bomb) is taken from each cylinder of tails and the U-235 content is determined by the mass spectrometer. The uranium content is taken at a factor of 67.616 % uranium which has been determined by averaging results of the drain line samples over long periods of time.

7.9 - The top product and side withdrawals are sampled and weighed in Bldg. K-601 by the coded chemicals group. Each cylinder is weighed on both a platform type Toledo print-weigh scale and a Henry Troemner balance (100 milligram sensitivity).

7.10 - Some effort has been devoted by Station CCC toward a mechanization of the Cascade inventory. The K-31 Bldg. has been mechanized with the thought in mind of extending this mechanization throughout the entire Cascade complex. The mechanization entails the key punching of the raw data sheets in which the data is averaged on a cell basis. These data include pressure, temperature, control valve position and delta P. The averages are substituted into the inventory equations and the equation is evaluated for the raw gas inventory on the 602-A. The raw gas inventory is corrected to a uranium inventory from on-stream contaminants which are calculated from line recorded data.

7.11 - When the necessary information is marked on the card, the cards are forwarded to the IBM 514 Reproducer (with mark-sense attachment) where the cards are read and punched accordingly.

7.12 - Future plans are for the mark-sense cards to be processed through the IBM-7090 after the key punching operation is completed.

7.13 - Inventory Procedures - Standard operating procedures are issued for obtaining the necessary Cascade inventory data. Prior to inventory a written notice is distributed to all supervisory personnel concerned, announcing the date and time of each inventory. In addition, operating instructions covering specific items are issued by the Uranium Control Group at least one day preceding the Cascade inventory.

7.14 - Each cylinder of Feed, Product, Intermediate Product and Tails is listed by cylinder number, gross, tare and net weights at inventory time.

7.15 - At inventory time all feed and withdrawals were suspended and the inventory measurements taken. The uranium in the hexafluoride gas in the Cascade proper is computed from calculated size factors and reported pressures, control valve positions, temperatures, and chemical impurities. The uranium-235 content is determined from a uranium-235 gradient based on mass spectrometer comparisons with synthetic standards for 53 samples removed from the Cascade. The uranium and U-235 content of the surge systems are based on calculated size factors and reported pressures and temperatures, together with the purity and uranium-235 content obtained by the laboratory measurements of 20 gas bulb samples withdrawn from the systems.

7.16 - The purge unit alumina trap inventories are based on weight gain measurements for uranium content, with the appropriate Cascade gradient value being used to obtain the uranium-235 content. However, these traps are usually changed out prior to inventory, thus reducing the uranium content.

7.17 - The material in the Product Purification unit (K-306-7) is inventoried after the UF_6 has been drained into the 5" diameter product cylinder, usually on the day following the Cascade inventory.

7.18 - Inventory Verification - The survey team participated in the physical inventories taken in the areas of product withdrawal, tails withdrawal, feed vaporization, SS storage and special sampling.

7.19 - No samples were taken; however, some check-weighings were performed utilizing the Military Standards Manual 105A. No significant discrepancies were noted and carbon copies of the inventory were taken to be reconciled to the Contractor's records.

7.20 - Opinion - It is the opinion of the survey team, based on our findings that the Contractor maintains adequate control over the SS material in the Cascade processing areas.

VIII. DECONTAMINATION, RECOVERY AND DIRECT FLUORINATION

8.1 - Measurements - Tube bundles, converter shells, compressors, etc. from the Cascade are not measured for uranium content as they are received in Decontamination because of the physical nature of the material. However, as they are decontaminated, the resulting solutions are measured on a volume basis and a one-liter sample is taken. The one-liter sample is analyzed for total uranium and U-235 content. Total uranium is determined gravimetrically after a penta ether extraction for purification and U-235 is determined by the optical spectrograph. The Cascades are then credited with withdrawals based on these volumes and analyses. That these measurements reflect essentially all uranium originally present is attested by the fact that only trace quantities are present in nickel and second water rinses from the decontamination operations. In addition to the one-liter sample mentioned above, a 600 ml. sample is taken and analyzed to determine if the solution in question should be reused or sent to recovery, i. e., whether original acidity and uranium loading capacity have been sufficiently utilized. Salvage receipts from all other plant areas are measured by the Coded Chemicals Account prior to transfer to Recovery. While returns from licensees may be processed with

non-licensee material, no licensee material is processed until any shipper-receiver differences have been resolved.

8.2 - Inventory Procedures - The Recovery operations are shut down to take the inventory. The presence of all cylinders on hand is verified and containers which have been received for processing but which have not been sampled are shown at shipper's value for uranium and U-235. The uranium content of undecontaminated equipment remains on Cascade Inventory. All uranium bearing decontamination solutions are pumped or taken to the Recovery Area, concentrated and sampled prior to inventory. A scoop sample is taken of the oxide produced in Recovery and the sample is analyzed for both total uranium and U-235.

8.3 - Inventory Verification - Decontamination and Recovery Operations were shut down at inventory time and the Direct Fluorination facility had been down for repairs for a month preceding inventory. The taking of samples from "safe" storage tanks was observed. The presence of all containers of Recovery Area solution feed or oxide product was verified. A large quantity of oxide was received into the facility about a week before inventory in preparation for a capacity test. By special arrangement, an inventory of this facility was taken before tower start-up and before any uranium was introduced or fluorinated and no material was added to or removed from the facility between actual inventory and 2400 January 31, 1961. The actual inventory was taken the morning of January 30, 1961.

8.4 - Opinion - It is the opinion of the survey team that Station CCC maintains adequate control over SS materials in this area.

IX. SAMPLING FACILITY (BLDG. K-601)

9.1 - The Sampling Facility at Station CCC is located in K-601 Bldg. and is designated Account No. 960, Coded Chemicals. Its function is to withdraw samples of UF_6 by means of both dry heat and steam heat cubicles into sample tubes for transfer to the Works Laboratory for analyses.

9.2 - Samples are presently being withdrawn from 5, 8, 10, and 12 inch cylinders. The sample containers are designated as follows:

R. tube, 170 grams capacity, miscellaneous usage.
FP. tube, 130 grams capacity, freeze point, for special control samples.
Harshaw Bomb, 2500 grams capacity used primarily for tails material (K-631 Bldg.) and Feed Plants product (K-1131 Bldg.).
250 gram tube - used for top product.
165 gram tube, intermediate product.

Samples are submitted to the Works Laboratory to these accounts:

Account 810 - Common Sample Flow - all areas of Works Laboratory.

Account 845 - Top Product Samples.

9.3 - Other services at Special Sampling include sampling of materials returned by licensees, UNH material from Carbide Y-12, and some repackaging of depleted UF_6 (from Carbide - Paducah Plant) from chlorine cylinders to other specified types for special purposes, for shipment to Carbide Y-12.

X. LABORATORY

10.1 - Members of the survey team toured the laboratory facilities and discussions were held with the Contractor concerning the equipment and the various methods of analysis employed both chemically and isotopically for the control of SS materials. The methods of analysis have not changed appreciably from those described in previous survey reports.

10.2 - Samples are received in the Sample Receiving section on an intra-plant SS transfer form. A data card is prepared indicating the type of analysis required for the sample. In the event sub-sampling is required, the sample is received, sub-sampled and then forwarded to Sample Receiving.

10.3 - (UF_6 Lab.) - This portion of the laboratory is devoted to the analysis of uranium in UF_6 contained in a fluorothene tube by the pyrohydrolysis method.

10.4 - Another analysis performed in this area is the ferric ammonium sulfate titration method which is utilized for the determination of uranium in less pure oxides.

10.5 - A colorimetric procedure for molybdenum determinations is also performed in this area in which thiocyanate is utilized as the coloring agent.

10.6 - Another portion of the Works Laboratory is engaged in the chemical separation of uranium from various impurities through an extraction technique utilizing carbitol or penta ether.

10.7 - A separate area is set up for titrating equipment using an automatic burette for uranium determinations in impure oxides and also has a set-up for the preparation of samples for the optical spectrograph.

10.8 - The Works Laboratory also includes a counting section in which quantitative determinations are made for:

(1) Alpha content in bio-assay samples.

(2) Alpha and beta content in various water samples.

(3) Gamma content of foils (consisting of S, Au, Np, Pu and O) in threshold detectors when needed. The Works Laboratory has been assigned the responsibility for the maintenance of these detectors located throughout the plant; consequently a control program is maintained through the application of routine analytical procedures.

10.9 - Another major section of the Works Laboratory is the Mass Spectrometer Section which is concerned with the isotopic analysis of UF_6 and mass scans of other gaseous materials.

XI. URANIUM STORAGE

11.1 - Our examination of the uranium storage areas (eight in number) was limited for this survey OR-147, to verification of the SS materials inventory in Account No. 951, SS storage of product cylinders. Product shipments originate here.

11.2 - We noted one physical change in the area from conditions existing previously, i. e., the weighing scales had been removed and we observed that the weighing of product cylinders now occurs at the Sampling Plant, Account No. 960. There were some cylinders present in the Product Storage Area which showed, by their markings, that other than product level material was contained therein. These cylinders are recorded in another account code and the color code used and the identifying tags appeared to differentiate them sufficiently from the product cylinders to preclude erroneous listing. However, we suggest that physically segregated areas be established for SS materials of significantly different assay.

11.3 - From our observation and inventory verification, we are of the opinion that Station CCC exercises generally adequate control over SS material in storage.

XII. INTERNAL CONTROL

12.1 - The origin of SS data by personnel in the internal material control areas and the subsequent recording and extension of such data by personnel in the SS accounting office creates a check and balance system defined as "internal control".

12.2 - In some instances, as cited below, this internal control fails to function in the usual manner of an internal material transfer document executed by a "shipper" and signed for by the "receiver". The following transfers are recorded via journal entry documents which are prepared, posted and filed by the SS accounting office.

From	To
Account 140, Product Withdrawals	- Account 960, Special Sampling
Account 960, Special Sampling	- Account 951, Product Storage
Account 200, Cascade	- (Account 140, Product Withdrawal) (Account 150, Special Withdrawal)
Account 160, Special Side Feed	- Account 200, Cascade
Account 115, Paducah Product Feed Point) Account 125, Feed Plant Product	) Account 200, Cascade
Account 200, Cascade	- Account 120, Depleted UF_6 Withdrawal

It is recognized that the transfers to and from the Cascade (No. 200) are of necessity a journal entry. However, the other transfers listed above should be made the subject of periodic review by Contractor management personnel to ascertain the propriety and accuracy thereof.

12.3 - The success of an internal control program is dependent, to a great extent, on the independence of the shipper and receiver. In order to furnish evidence that such control is in force, it is very necessary that both the shipper and receiver sign, or at least initial, the transfer documents. Unsigned documents should be returned for signature before the transaction is considered complete.

12.4 - In light of the over-all accuracy of the Station's SS material control program, we are of the opinion that the degree of internal control exercised by Station CCC is adequate to protect the interest of the Government. The Contractor is urged, however, to re-examine the internal control structure in view of the points raised in the preceding paragraphs.

XIII. SS MATERIAL LEDGERS, TRANSFERS AND REPORTS

13.1 - The SS Material Control Ledgers at Station CCC have been prepared in the form of IBM lists. Similar lists of subsidiary ledger accounts represent the internal material control areas. Although on the surface it appears that the IBM system produces the records and the reports, closer examination reveals that some phases of the data accumulation are initially prepared on working papers and supported by adding machine tapes. The "ledgers" are supported by AEC-101 and 388 forms, internal transfer documents, sample requisitions, material tallies, weight tickets, journal entries, and intra-plant correspondence.

13.2 - The following are minor points of exception noted during the course of the survey which need clarification and/or correction. These paragraphs constitute a repetition of prior oral discussion with the SS Materials Accountant at Station CCC.

a. It was sometimes difficult to determine which weight ticket supported a certain AEC-101 or AEC-388 shipping document. It is suggested that a cross-reference on the weight ticket to the applicable transfer document would be in order.

b. The ledger which reflects cumulative quantities usually is not prepared until after the material balance reports have been submitted to the AEC.

c. For the period ending January 31, 1961, the ledger reflected a different quantity for the cumulative U-235 MUF of the Cascade than the report.

d. The January 31, 1961, inventory of Account No. 960, Special Sampling, was overstated 5,520 grams uranium and 12 grams U-235 due to a transposition error in key punching field data on the IBM tabulator.

13.3 - SS Material Receipts and Shipments are recorded on AEC-101 shipping documents, for routine transfers, and on Form AEC-388, Leased Material document for licensee transactions. As in the past, we note that the Contractor delays the dispatch of receiver's data beyond the period specified in part 7400 of the AEC Manual.

13.4 - The IBM ledger included control accounts for licensee transactions. These control accounts are supported by subsidiary accounts maintained on ledgers posted by a Remington-Rand bookkeeping machine. However, these subsidiary ledgers were not used in preparing the material balance reports and off-setting errors occurred in the cumulative fiscal-year-to-date quantities as follows:

a. Cumulative report, December 31, 1960, erroneously included receipt from licensee, Spencer Chemical Company, as receipt from licensee, Mallinckrodt Chemical Works. The material (66,110 grams uranium and 1,660 grams U-235) was received from Spencer Chemical Company in October 1960, was correctly reported on the October monthly section of the report, but was incorrectly reported in the cumulative section of the same report.

b. The fiscal-year-to-date section of the January 31, 1961, material balance report included as a shipment to licensee, Davison Chemical Company, 779,705 grams uranium and 20,329 grams U-235, which should have been included in shipments to licensee, Mallinckrodt Chemical Works, Nuclear Division. The shipments were made during January 1961 and were correctly reported in the monthly section of the material balance report.

13.5 - The SS Material Balance Reports are attractive in appearance and well prepared. The report, in addition to containing the required AEC information, contains additional information required by Union Carbide Nuclear Company.

13.6 - We note that in January 1961 the Contractor opened a new account, No. 990, under the Coded Chemicals balance area. This account is used as a clearing account for the handling of licensee receipts to reflect the material unaccounted for (BPID) resulting from the AEC's policy of accepting the licensee's stated quantities whenever the shipper-receiver differences between Station CCC and the licensee fall within statistically established limits of error. As of January 31, 1961, the fiscal year to date material unaccounted for in the account was 10,988 grams of uranium and 902 grams of U-235 deficiency. The receipts into this account for the period July 1, 1960, to January 31, 1961, are: 9,706 Kgs. of uranium and 242 Kgs. U-235. The MUF is 0.113 % of uranium and 0.372 % of U-235 receipts which is considered reasonable. The review of this account indicates that there is no significant bias in either shipper or receiver values.

13.7 - It is the opinion of the survey group that Station CCC adequately records or reports the results of the SS materials transactions.

XIV. STATISTICS

14.1 - Sampling Programs and Studies - Station CCC's top product sampling program has not appreciably changed since the previous survey. Samples are taken from individual top product cylinders, and these cylinders are composited on a daily basis.

14.6 - Station CCC's past experience with the uranium analysis of Cascade tails production has indicated that this material is produced with a uniform high purity. Station CCC is presently analyzing five cylinders of tails material per week by the freeze-point depression method of uranium analysis. Every cylinder of tails material is drain-line sampled for isotopic content. An average analysis of 67.616 percent uranium is assigned to all cylinders of Cascade tails produced. This present factor was established in June 1960. This factor has varied between 67.614 to 67.616 for the last two years.

14.7 - After reviewing Cascade tails data accumulated during the survey period, it is evident that the above uranium factor is well established.

14.8 - Station CCC is proposing to change the present tails material sampling program. Production personnel are presently utilizing a mass spectrometer to continuously monitor the UF_6 stream at the bottom of the plant. The proposal is to tie this mass spectrometer with the tails withdrawal system so that it would monitor the UF_6 stream being withdrawn as tails material. The average of the mass spectrometer readings would be the U-235 value assigned to that particular cylinder or cylinders. Individual cylinder samples would also be periodically taken to check against the mass spectrometer readings. The one sample per day for uranium analyses would still be taken under this proposed sampling program.

14.9 - Assay Dilution Tests - During the third quarter of 1959, four assay dilution tests were completed. These tests were used to verify the accuracy of the inventory calculations for the dynamic inventory of a unit. The results of the assay dilution tests are as follows:

Location	Calculated Inventory (Kgs.)	Assay Dilution Measured Inventory (Kgs. U)	$\frac{(\text{Assay Dilution Minus Calculated})}{\text{Calculated}} \times 100$
303-8 (K-25)			
305-9 (K-25)			
304-2 (K-25)			
402-6 (K-27)			

The test shows the calculated (dynamic) inventory to be biased low from 7.00 % to 12.00 % of the inventory as measured by the assay dilution technique.

14.10 - In the uranium material balance equation (Cascade Balance Area) the influence of this bias will not be evident under continuous steady-state operating conditions.

The balance equation if adjusted for the bias would be

$$BPID_U = (B_I + \Delta_I) + R - (E_I + \Delta_I) - S$$

Where Δ_I represents the inventory bias.

In otherwords, the inventory bias (Δ_I) would be the same for the Beginning Inventory and Ending Inventory, and therefore the Δ_I's would cancel when considering the Beginning Inventory and Ending Inventory to be of the same magnitude. The BPID for uranium would not be influenced by the bias in the calculated inventory. Correction for the effect of this bias would, however, affect the cumulative BPID.

14.11 - Provided the Cascade assay gradient remains relatively unchanged, the same situation is true for the uranium-235 BPID. When the assay gradient does change appreciably over a balance interval, the effect of the bias can be seen in the equation for uranium-235.

$$BPID_{U-235} = (B_I + \Delta_I)A + R - (E_I + \Delta_I)\,A' - S$$

Where A and A' represent the beginning and ending Cascade average assays, respectively.

When the assay gradient changes appreciably over a balance period, the $\Delta_I A$ and $\Delta_I A'$ are not equal and will not cancel.

14.12 - The information derived from these tests is utilized by Station CCC when determining possible causes for any particular BPID experienced in the Cascade balance. Station CCC has plans to perform assay dilution tests on equipment representative of the equipment in Bldgs. K-29, K-31, and K-33. Since the assay dilution test is expensive, it is used only after considerable planning and on small segments of the Cascade at any one time.

14.13 - Scales Control - Station CCC's scale program has not been changed appreciably since the last survey. These controls are considered adequate with respect to the materials concerned.

14.14 - In the previous survey, the survey team presented a lengthy evaluation of the weight biases between CCC and CKY on CCC's tails and CKY's product.

14.15 - As was reported in the last survey, the magnitude of the weight bias (CCC's tails material to CKY) was an average of 2.45 pounds per cylinder (CKY high or CCC low). This value was based on weight data from January 1959 through October 1959 (2,830 two and one-half ton cylinders).

14.16 - Using the more recent data of this survey period, the magnitude of this weight difference has greatly decreased. The average difference per cylinder is 0.24 pounds (CKY high or CCC low). This value is based on weight data from January 1960 through December 1960 (3,878 two and one-half ton cylinders). It is apparent that cylinder weights in this flow have not been a problem to Station CCC during this survey period.

14.17 - The survey team also reported in the last survey that a weight bias existed between CCC and CKY on CKY's product material. The magnitude of this weight bias was an average of 1.84 pounds per cylinder (CCC high or CKY low). This value was based on available weight data from January 1959 through October 1959 (1,790 two and one-half ton cylinders).

14.18 - Using the more recent data of this survey period, the magnitude of this weight difference has also greatly decreased. The average difference per cylinder is 0.33 pounds (CCC high or CKY low). This value is based on weight data from January 1960 through December 1960 (1,884 two and one-half ton cylinders). It is also apparent that cylinder weights in this flow have not been a problem to Station CCC during the survey period.

14.19 - Station CCC maintains empty and full standard check-weigh cylinders at K-33 (Feed Point) and K-631 (Tails Withdrawal). These full and empty check-weigh cylinders are used twice per shift (beginning and middle of each shift) in each of the above two areas. These check-weigh cylinders are interchanged between Bldgs. K-33 and K-631 at regular intervals.

14.20 - A check of the scales control data showed the K-33 and K-631 scales were maintained in good working condition during the survey period. During the period January 1960 through December 1960, the average weight difference (weight difference observed minus the Standard weight) was 0.32 pound per cylinder when the full check-weigh cylinder was weighed 2,151 times at K-33, and the average weight difference was -0.71 pound per cylinder when the empty check-weigh cylinder was weighed 2,152 times at K-33.

14.21 - During the same period, the average weight difference was -0.09 pound per cylinder when the full check-weigh cylinder was weighed 2,019 times at K-631, and the average weight difference was -0.04 when the empty check-weigh cylinder was weighed 1,924 times at K-631. All the above differences are within the range of the scale precision.

14.22 - Presently Station CYT is accepting CCC's weights on product, if CYT's weight is within 10 grams of CCC's weight. If the difference is greater than 10 grams, both stations negotiate as to which weight is the correct weight. Station CCC's analytical values on these flows are also accepted by Station CYT subject to the interplant analytical program.

14.23 - The survey team witnessed the routine calibration of the Henry Troemner balances in Bldg. K-601. These balances are the official accountability balances for product, material going to CYT. The calibration of the two Toledo scales used to substantiate the Henry Troemner weights was also observed. These scales and balances are calibrated every day by scale maintenance personnel. The survey team concurs that the calibration program of these important scales and balances is adequate.

14.24 - Works Laboratory - The Works Laboratory quality control program has not changed significantly since the last survey. This program consists mainly of preparing and analyzing samples of uranium of known concentration and assay. Samples for uranium accountability are analyzed in the Uranium Analysis and Spectrometer Sections.

14.25 - The chief types of chemical control materials in use are pure UF_6, UO_3, alumina, chemically pure and impure U_3O_8, and uranium in aqueous solutions. The optical spectrograph is used in determining the isotopic content of most of the samples whose uranium content has been determined by chemical analysis. The optical spectrograph samples such as alumina, impure U_3O_8, and aqueous solutions are the same as those used for chemical analysis.

14.26 - Mass spectrometer controls include the routine analysis of a batch of ORGDP product control material (UF_6) for U-235 and a daily mass spectrometer analysis of product samples withdrawn for the Mass Spectrometer Laboratory.

14.27 - This laboratory receives approximately 65 hexafluoride samples from each monthly Cascade inventory extending from ORGDP tails material to ORGDP product concentrations. Submitted along with these inventory samples are laboratory control samples of the following assay levels: ORGDP product 72% 45%, 26%, 7%, 2%, 0.76%, 0.4%.

14.28 - Analytical precisions of the Works Laboratory analyses are expressed as limits of error per analysis. These limits inclose the interval which has a 95% probability of containing all the sample results in a population. They are calculated from the agreement among control sample results and are expressed as a percent of the control sample mean. The analytical bias extimates are obtained by subtracting the theoretical mean, if any, from the control sample mean and expressing this as a percent of the theoretical mean. In cases where the theoretical mean is not known except through analytical results, the bias is estimated as being less than some maximum figure.

14.29 - The interplant analytical control program has not appreciably changed since the last survey. Station CCC receives two samples of CKY product per week, and CCC also samples certain CKY product cylinders each month. Station CCC also sends two samples of their tails material per week to CKY. The analytical data is exchanged between both stations.

14.30 - Six P-10 tube samples of Cascade product material representing sub-samples in duplicate of three Harshaw bomb composite samples are analyzed weekly by CYT.

14.31 - Limits of Error of the Material Unaccounted For - The statistical methods of calculating these limits have not appreciably changed since the last survey. These methods are considered adequate to establish valid limits of error for the deficiencies of the Balance Areas concerned.

XV. MATERIAL UNACCOUNTED FOR

15.1 - In order that the AEC survey team may better evaluate the magnitude of the MUF's for the Total Plant, Feed Manufacturing Plant, Cascade, and Recovery Balance Areas, MUF quantities experienced within these Balance Areas were normalized in the following manner:

$$\% \text{ MUF} = (\text{MUF} \div \text{Beginning Inventory} + \text{Receipts}) \times 100$$

The control limits have been revised, if necessary, since the last survey. The data from July 1956 through December 1959 were used to calculate new control limits for X charts (99% probability limits), X charts (95/95 tolerance limits) and R charts (99% probability limits). The average of the % MUF's for the three month period is plotted on the $\bar{X}$ chart while the range of the % MUF's for the three month period is plotted on the R chart. Each monthly % MUF is plotted on the X chart. A parenthesis indicates an MUF gain.

15.2 - Total Plant (Uranium) - The % MUF's for the survey period (February 1960 through January 1961) are listed in Table I. No % MUF fell outside the limits of the $\bar{X}$, R, and X charts. No further comments are necessary.

15.3 - Feed Manufacturing Plant (Uranium) - The % MUF's for this survey period are listed in Table II. The % MUF's for August and October, 1960, were outside the control limits of the X chart and the three-month period of July through September 1960 was outside the control limits of the R chart. The following information is presented on this period:

15.3 - (Continued)

	MUF (Kgs. U.)	% MUF
July 1960	2,499	0.54
August 1960	(4,080)	(0.94)
September 1960	3,076	0.94
October 1960	(2,086)	(0.96)
	(591)	(0.42)

In connection with the above period the cumulative MUF was low, but the month-to-month variation was higher than usual. Station CCC was not able to pin-point an area of difficulty, but there are contributing factors that could have caused these fluctuations, and they are listed below:

(1) Approximately 75% of the inventory is on estimates.

(2) Large hold-up of UF_6 "heels" in the cold traps which is estimated at inventory time (approximately 4000 Kgs. Uranium).

(3) Alternate production of depleted, normal, and enriched reactor tails material during this period.

15.4 - The survey team feels that these factors are not in total, justification of the fluctuations of the above period, but they are factors that can cause the Feed Plant to experience higher than usual MUF's over a short period of time. It is obvious from Table II that these higher MUF's were experienced only for a short period of time.

15.5 - Using the propagation of error technique Station CCC has derived limits of error for MUF's in the Feed Plant along with other Balance Areas. At present this limit of error is approximately 1000 Kgs. uranium and 8 Kgs. U-235 on a monthly basis. Station CCC believes that this limit of error is possibly understated because the variance associated with the ending inventory is low. Station CCC plans to review the calculations of the Feed Plant limit of error value.

15.6 - Cascade (Uranium) - The % MUF's for this survey period are listed in Table III. The % MUF for November 1960 was outside the limits for the X; also the range of the % MUF's for the three month period of October, November, and December 1960, was outside the limit for the R chart. The breakdown of this three month period is as follows:

	MUF (Kgs. U.)	% MUF
October 1960	4,355	0.60
November 1960	(4,822)	(0.66)
December 1960	(504)	(0.07)

15.6 - (Continued)

Radiation scans detected abnormal readings on the wing by-pass housing between cells 3 and 5 in K-902-4 and between cells 7 and 9 in K-902-2. Heat to these housings was increased to effect the revaporization of material.

15.7 - Cascade (Uranium-235) - The % MUF's for this survey period are listed in Table IV. No % MUF's fell outside the limits of the $\bar{X}$, R, and X charts, but the MUF loss of 98 Kgs. U-235 experienced in July 1960, was higher than normally experienced in this account.

15.8 - Station CCC reports that following this unusual MUF experience in July, radiation scans were made throughout the Cascade but no appreciable material accumulations were found. A complete Cascade inventory was repeated on August 17, and the U-235 difference for this 17 day period was 42.3 Kgs.. which indicated a continuation of the July experience.

The MUF experience for the latter part of August and early September indicated that the tendency toward abnormal MUF's observed in July and early August had been arrested and the trend had been reversed.

15.9 - Recovery (Uranium) - The % MUF's for this survey period are listed in Table V. Only the % MUF for December 1960, fell outside the control limits of the X chart, and this % MUF in turn caused the three-month period of October, November, and December 1960, to fall outside the control limits of the R chart.

15.10 - An investigation during this period of the material balance experience for the oxide fluorination system in November indicated that contaminated materials and equipment were removed to other accounts with insufficient credit. This was reflected in the recovery account both in November and in December. Also there was material sent to recovery from storage that contained more than was estimated.

STATION CCC

TABLE I.

MATERIAL UNACCOUNTED FOR - PLANT BALANCE
TOTAL URANIUM

Month	Year	Beginning Inventory Plus Receipts (Kgs.)	MUF (Kgs.)	Percent MUF
February	1960		3,973	
March	1960		(235)	
April	1960		850	
May	1960		1,859	
June	1960		338	
July	1960		2,123	
August	1960		(4,107)	
September	1960		4,563	
October	1960		2,507	
November	1960		(4,840)	
December	1960		611	
January	1961		855	
			8,497	

Monthly Average MUF = 708.1 Kgs. Uranium

STATION CCC

TABLE II.

MATERIAL UNACCOUNTED FOR - FEED MANUFACTURING PLANT

TOTAL URANIUM

Month	Year	Beginning Inventory Plus Receipts (Kgs.)	MUF (Kgs.)	Percent MUF
February	1960	492,800	2,965	0.60
March	1960	593,809	(280)	(0.05)
April	1960	515,791	89	0.02
May	1960	526,731	(332)	(0.06)
June	1960	612,331	1,193	0.19
July	1960	464,931	2,499	0.54
August	1960	432,337	(4,080)	(0.94)
September	1960	326,214	3,076	0.94
October	1960	216,477	(2,086)	(0.96)
November	1960	394,457	534	0.14
December	1960	433,796	1,589	0.37
January	1961	379,497	537	0.14
			5,704	0.93

Monthly Average MUF = 475.3 Kgs. Uranium

Monthly Average % MUF = 0.08

STATION CCC

TABLE III.

MATERIAL UNACCOUNTED FOR - CASCADE

TOTAL URANIUM

Month	Year	Beginning Inventory Plus Receipts (Kgs.)	MUF (Kgs.)	Percent MUF
February	1960		597	
March	1960		164	
April	1960		366	
May	1960		2,144	
June	1960		(859)	
July	1960		(35)	
August	1960		(558)	
September	1960		1,284	
October	1960		4,355	
November	1960		(4,822)	
December	1960		(504)	
January	1961		633	
			2,765	

Monthly Average MUF = 230.4 Kgs. Uranium

STATION CCC

TABLE IV.

MATERIAL UNACCOUNTED FOR - CASCADE

URANIUM-235

Month	Year	Beginning Inventory Plus Receipts (Kgs.)	MUF (Kgs.)	Percent MUF
February	1960		32	
March	1960		27	
April	1960		(50)	
May	1960		28	
June	1960		(32)	
July	1960		98	
August	1960		15	
September	1960		6	
October	1960		74	
November	1960		(42)	
December	1960		71	
January	1961		54	
			281	

Monthly Average MUF = 23.4 Kgs. Uranium-235

STATION CCC

TABLE V.

MATERIAL UNACCOUNTED FOR - RECOVERY AREA

TOTAL URANIUM

Month	Year	Beginning Inventory Plus Receipts (Kgs.)	MUF (Kgs.)	Percent MUF
February	1960	488	32	6.56
March	1960	390	21	5.38
April	1960	304	1	0.33
May	1960	859	(65)	(7.57)
June	1960	384	(6)	(1.56)
July	1960	157	23	14.65
August	1960	316	(11)	(3.48)
September	1960	455	49	10.77
October	1960	278	(6)	(2.16)
November	1960	461	12	2.60
December	1960	226	(100)	(44.25)
January	1961	281	(24)	(8.54)
			(74)	(27.27)

Monthly Average MUF = (6.2) Kgs. Uranium

Monthly Average % MUF = (2.27)

STATION CCC

SURVEY NO. OR-147

APPENDIX A.

A1 DESCRIPTION OF OPERATIONS

1.1 - The primary function of the ORGDP is to produce uranium enriched in the U-235 isotope.

1.2 - Isotope separation at ORGDP is based on the higher rate of diffusion of the lighter U-235 F_6 molecule through a porous barrier as compared to the rate for U-238 F_6. This separation is accomplished by successively pumping gaseous UF_6 through some 4000 "converters" which contain bundles of porous barrier tubes. A portion of the gas entering each converter diffuses through the tubes, becoming slightly enriched, and is then pumped to the next upstream converter; the depleted portion is recycled to down-stream converters. These converters and associated equipment are termed a gaseous diffusion cascade.

1.3 - Major feeds for the ORGDP Cascade are UO_3 from SDA reactor tails, Port Hope or NLO normal and HGE slightly enriched reactor tails, and Paducah Product UF_6, respectively assaying about 0.64, 0.71, 0.86 and 1.60% U-235.

1.4 - Most of the enriched uranium product from the ORGDP is shipped to Y-12 for further fabrication.

1.5 - Uranium depleted in U-235 (tails) is shipped to Paducah at an assay of about 0.42 for further depletion.

1.6 - Various service-type operations are also carried on at ORGDP - Feed preparation, Analytical Methods Development, Maintenance, Decontamination, Barrier Manufacture, Operations Analysis, etc.

A2 MATERIAL FLOWS IN FEED PLANT

2.1 - Major UO_3 feeds, as mentioned in A1.3, are successively:

(a) received and handled in five-ton hoppers
(b) reduced to UO_2 in two H_2 atmosphere, fluidized bed reactors
(c) hydrofluorinated with counter current HF in two, screw reactors
(d) fluorinated to UF_6 in 15% excess F_2 in four tower fluorinators.

The gaseous effluent from the four fluorinating towers (including the UF_6 product) successively passes through:

(a) a cyclone separator
(b) a sintered Monel tube-type filter
(c) water cooled ten-ton Modine cold traps
(d) liquid CO_2 cooled cold traps operating at -30° F
(e) then to a "clean-up" tower fluorinating reactor where remaining F_2 values are utilized.

2.1 (Continued)

As desired, product UF_6 in the Modine or CO_2 cold traps is melted and drained into either 2-1/2 or 10 ton cylinders for eventual feeding to the ORGDP or Paducah Cascades. Some Hanford 0.865 reactor tails UF_6 is blended up to 0.947 assay for use as production reactor fuel.

2.2 - Different assay materials are not processed simultaneously; they are campaigned by assay.

2.3 - Although the plant has been processing about 11 tons of uranium each on-stream day (being on-stream 10 out of each 14 days), the plant capacity is roughly 20 tons uranium each on-stream day.

2.4 - The flow of Belgian UO_3 ended in October 1960. Small quantities of CYT U_3O_8 are processed in the CCC Feed Plant.

2.5 - A large fluorine plant containing some 50 electrolytic F_2 generators (from HF) supports the above operations.

A3 MATERIAL FLOWS IN THE CASCADE

3.1 - Major Feeds (see A1.3) as UF_6, are vaporized in the K-33 Feed Vaporization Facility and pumped into the Cascade at points determined by assay. Lesser feeds, such as licensee returns, are fed at appropriate assay points.

3.2 - Based on assay, it may be considered that UF_6 enters the Cascades in K-33 and flows down through K-33, K-31 and a few cells in K-27 to the tails withdrawal point in Unit 402-1. It flows up through K-33, K-31, K-29, K-27 and K-25 to the top product withdrawal point Top product weight is only a few tenths percent of feed weight, the bulk of the latter going to tails.

3.4 - Tails withdrawn from Unit 402-1 are pumped to K-631, condensed, drain line sampled, and then drained into 2-1/2 ton cylinders.

3.5 - Product is condensed in 5-inch diameter product cylinders and taken to a storage area. Enriched withdrawals at other assays are made in a similar manner.

A4 DECONTAMINATION, RECOVERY AND DIRECT FLUORINATION

4.1 - Process equipment in the gaseous diffusion cascade is subjected to continual deposition of uranium fluorides. When such equipment is removed from the cascades, it must be decontaminated for health physics and for economic reasons. A large and efficient facility has been established in C-1420 for this purpose. Significant amounts of licensee materials also are returned to the cascades via this facility.

4.2 - Decontamination - Tube bundles and converter shells are carried on a conveyor through compartments where they are successively treated with an HNO_3 spray, two water rinses, and an air blast. The second water rinse generally contains so little uranium that it is discarded. Barrier tubes are then sawed out of tube bundles,

4.3 - Compressors and small items are decontaminated manually.

4.4 - Recovery - Several operations take place in this area:

(a) Various solids, such as alumina, are dissolved in the continuous dissolver.

(b) Decontaminating solutions are adjusted for Uranium and NO_3^- concentration and Ph prior to solvent extraction.

(c) Adjusted solutions are processed through a single TBP solvent extraction cycle in either a high capacity counter current column system or a low capacity mixer-settler system.

(d) Purified uranyl nitrate solution from solvent extraction (in c above) or from Station CYT is concentrated, drum dried and calcined to U_3O_8.

4.5 - Direct Fluorination - U_3O_8 from Recovery is transferred from drums to the fluorinating tower feed hopper by a fluidized air conveyor whose exhaust is cleaned with sintered tube filters and a double Cambridge filter which removes particulate matter down to 0.3 microns in size. The five inch diameter fluorinating tower is screw fed from this hopper and operates on about 30% excess fluorine. Gaseous effluent (including product UF_6) from the tower is passed successively through (1) a sintered Monel tube type filter, (2) either of two 5" or two 10" Modine cold traps (depending on assay) and (3) four condensers in series (5" diameter product cylinders immersed in -70° F. dry ice - perchloroethylene slush) and (4) an exhaust to atmosphere. The tower is equipped with an ash receiver.

4.6 - The Direct Fluorination Tower has reduced fluorination costs in some instances by a factor of ten. The old pot-type fluorinators have been discarded.

STATION CCC

SURVEY NO. OR-147

APPENDIX B.

Reference: Letter dated June 7, 1961, from A. P. Huber, Plant Superintendent, ORGDP, to the attention of C. A. Keller, Director, Production Division, OROO, subject: "Draft of Survey Report, OR-147, Station CCC".

The Contractor states, in the referenced letter, that the draft of the survey report has been reviewed and that no significant errors in fact are contained therein.

In accordance with paragraph 2 of the letter, Paragraph 4.4, Section IV. of the report, is revised in order to make it clear that cumulative (year-to-date) quantities in the IBM ledger are printed after the submission of the Material Balance Reports for Station CCC.

Date: June 19, 1961

William B. Kenna for
E. D. Marshall, Chief
Nuclear Materials Control Branch

for Russell E Lee
Charles A. Keller, Director
Production Division
Oak Ridge Operations

Distribution:
1A - D. E. George
2A - C. E. Center
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UNION CARBIDE NUCLEAR COMPANY - OAK RIDGE GASEOUS DIFFUSION PLANT - OAK RIDGE, TENNESSEE - SURVEY NO. OR-147

SUMMARY MATERIAL BALANCE STATEMENT - URANIUM AND U-235 ACCOUNTS - FISCAL YEAR TO DATE, JANUARY 31, 1961

	DEPLETED URANIUM (Kgs.U.)	DEPLETED URANIUM (Kgs.U-235)	NORMAL U. (Kgs. U.)	U BELOW 75% U-235 (Grams U.)	U BELOW 75% U-235 (GramsU-235)	U ABOVE 75% U-235 (Grams U)	U ABOVE 75% U-235 (GramsU-235)
Beginning Inventory, July 1, 1960	313,171	1,684	205,612	270,949,540	3,360,066	795,372	717,715
Receipts, per Schedule A.	3,868,357	16,982	1,272,414	2,101,503,779	32,178,469	20,182,503	18,821,412
Beginning Inventory Plus Receipts	4,181,528	18,666	1,478,026	2,372,453,319	35,538,535	20,977,875	19,539,127
Removals, per Schedule B.	3,951,818	17,568	1,229,365	1,910,766,793	30,543,924	20,237,270	18,858,188
Ending Inventory, January 31, 1961	229,253	1,106	248,560	460,894,900	5,000,838	732,921	672,885
Removals Plus Ending Inventory	4,181,071	18,674	1,477,925	2,371,661,693	35,544,762	20,970,191	19,531,073
Book Physical Inventory Difference	457	(8)	101	791,626	(6,227)	7,684	8,054

UNION CARBIDE NUCLEAR COMPANY - OAK RIDGE GASEOUS DIFFUSION PLANT - OAK RIDGE, TENNESSEE - SURVEY NO. OR-147
SCHEDULE A - MATERIAL RECEIPTS - URANIUM AND U-235 ACCOUNTS - FISCAL YEAR TO DATE - JANUARY 31, 1961

RECEIVED FROM	DEPLETED URANIUM (Kgs.U.)	DEPLETED URANIUM (Kgs.U-235)	NORMAL (Kgs.U.)	U. BELOW 75% (Grams U.)	U. BELOW 75% (GramsU-235)	U. ABOVE 75% (Grams U.)	U. ABOVE 75% (GramsU-235)
AGE Gen. Elec. Co.,Atomic Power Equip.			5	802,353	30,852		
CKY UCNC, Paducah Ky.	54,567	161	495,460	1,708,779,964	25,551,824		
CYT UCNC, Y-12 Plant	948	5		104,212,670	1,095,786	63,126	58,862
GAT Goodyear Atomic Corp.			46,967	14,094	228	119	105
HGE Gen. Electric Co., Richland				175,414,726	1,493,271		
LDC Ledoux and Co., Inc.			32				
MAL Mallinckrodt Chem. Works,Nuclear Div.				1,036,872	21,757		
MCW Mallinckrodt Chem. Works, St. Charles			72,110				
MDC W. R. Grace and Co., Davison Chem.Div.				4,954,077	127,761	135	126
NBL New Brunswick Laboratory			34				
NLO National Lead Co. of Ohio			184,400	381	4		
ORL Oak Ridge National Laboratory	19	0	24				
RMA USAEC, Headquarters Office			468,356				
ROA University of Rochester			4				
SCC Spencer Chemical Co.			1	77,305	2,186	603	554
SDA E. I. duPont deNemours and Co.,Inc.	410,308	2,445					
LICENSEES			751	8,945,187	228,681	9,427	8,262
CASCADE	3,366,920	14,096	5	58,194,629	3,347,724	20,109,093	18,753,503
Transfers from Depleted Uranium			1,631	650,054	3,172		
Transfers from Normal Uranium	32,354	233		38,409,501	264,344		
Transfers from Uranium Below 75%	3,241	42	2,634				
Transfers from Uranium Above 75%				11,966	10,879		
TOTALS	3,868,357	16,982	1,272,414	2,101,503,779	32,178,469	20,182,503	18,821,412

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UNION CARBIDE NUCLEAR COMPANY - OAK RIDGE GASEOUS DIFFUSION PLANT - OAK RIDGE, TENNESSEE - SURVEY NO. OR-147
SCHEDULE B - MATERIAL REMOVALS - URANIUM AND U-235 ACCOUNTS - FISCAL YEAR TO DATE - JANUARY 31, 1961

REMOVED TO	DEPLETED URANIUM (Kgs. U.)	DEPLETED URANIUM (Kgs.U-235)	NORMAL U. (Kgs.U.)	URANIUM BELOW 75% (Grams U.)	URANIUM BELOW 75% (Grams U-235)	URANIUM ABOVE 75% (Grams U.)	URANIUM ABOVE 75% (Grams U-235)	CASCADE (Grams U.)	CASCADE (GramsU-235)
ANL Argonne National Laboratory			504	12	4	2	2		
CGE Gen.Elec.Co.,ANP Dept.Cincinnati				40,906	618				
CKY U.C.N.C., Paducah, Ky.	3,445.426	14,601							
GAT Goodyear Atomic Corporation	228	1	15,957	1,427,921	12,288	124	109		
RGE Gen. Electric Co.,Richland			19	122,380	1,046				
LDC Ledoux and Co., Inc.			23						
MAL Mallinckrodt Chem.Works,Nuclear Div.	100	0	1,132	5,769,833	222,563	84,215	78,473		
MCW Mallinckrodt Chem.Works,St.Charles	23	0	52						
MDC W. R. Grace and Co., Davison Chem.				39,476,951	1,336,477	7,737	7,213		
NBL New Brunswick Lab.			11						
NLO National Lead Co. of Ohio			134						
ORL Oak Ridge Nat. Laboratory	33	0							
RMA USAEC, Headquarters Office			129						
SDA E.I.duPont de Nemours and Co.,Inc.	385	2							
SFA USAEC, Albuquerque Operations Office	4	0	2						
Leases to Licensees				3,612,664	82,303	1,107,547	1,029,145		
Sales to Licensees	1,927	4	14						
Cascade	478,329	2,892	1,140,460	1,848,977,862	26,964,146	317,865	281,474		
Approved Inventory Write-Offs	246	2	157	91,000	894	18	17		
Transfers to Depleted Uranium			32,354	3,240,502	41,716			3,366,919,839	14,096,021
Transfers to Normal Uranium	1,631	10		2,633,802	18,927			4,953	36
Transfers to Uranium Below 75%	650	3	38,410			11,966	10,879	58,194,629	3,347,724
Transfers to Uranium Above 75%								20,109,093	18,753,503
TOTALS									

TOP SECRET

UNION CARBIDE NUCLEAR COMPANY - OAK RIDGE GASEOUS DIFFUSION PLANT, OAK RIDGE, TENNESSEE
SUMMARY MATERIAL BALANCE REPORT - SS MATERIALS OTHER THAN U-235
FISCAL YEAR TO DATE, JANUARY 31, 1961

SURVEY NO. OR-147

	THORIUM (Kilograms)	U-233 (Grams)	Plutonium (Grams)
Beginning Inventory, July 1, 1960	7.69	15.23	10.
Receipts:			
ORL, Oak Ridge National Laboratory		2.00	
Beginning Inventory Plus Receipts	7.69	17.23	10.
Removals	0	0	0
Ending Inventory, January 31, 1961	7.19	16.94	10.
Removals Plus Ending Inventory	7.19	16.94	10.
Book-Physical Inventory Difference	.50	.29	0

TOP SECRET

DISTRIBUTION

1. K-25 Site Records (RC)
2. ChemRisk/Shonka Research Associates
3. DOE Public Reading Room
4. S. G. Thornton (K-25 EMD)